

Climate's Long-term Impacts on Metro Boston (*CLIMB*)

Matthias Ruth

*Professor and Director, Environmental Policy
Program School of Public Affairs
University of Maryland, College Park*

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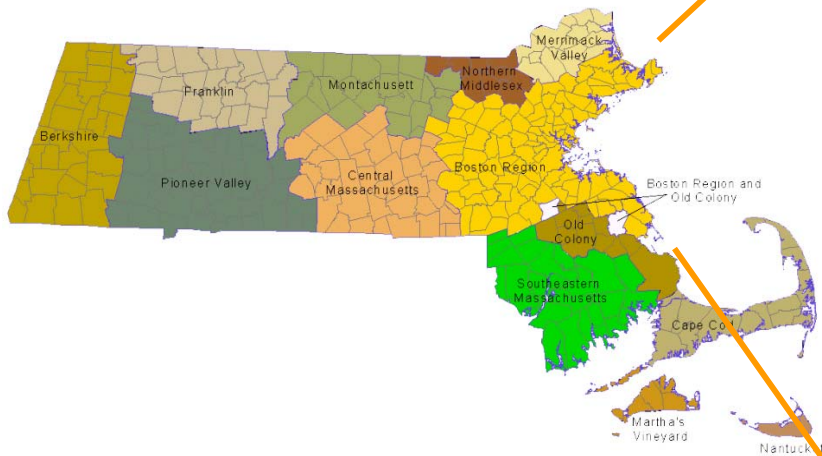


Climate Change and Urban Infrastructure

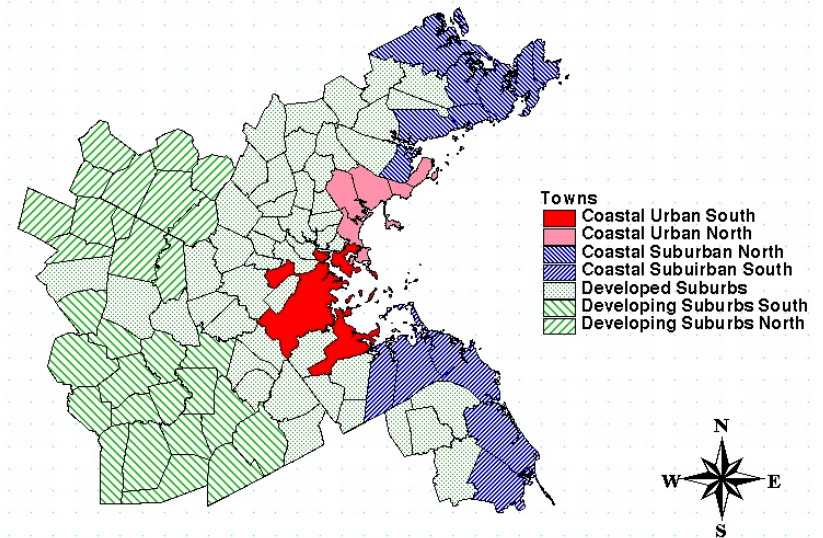
- ❑ Climate's Long-term Impacts on Metro Boston (*CLIMB*)
 - Study Region
 - Structure
 - Methodology
 - Applications and Findings
- ❑ Six Challenges for Research and Policy



Metro Boston



MAPC zones for CLIMB



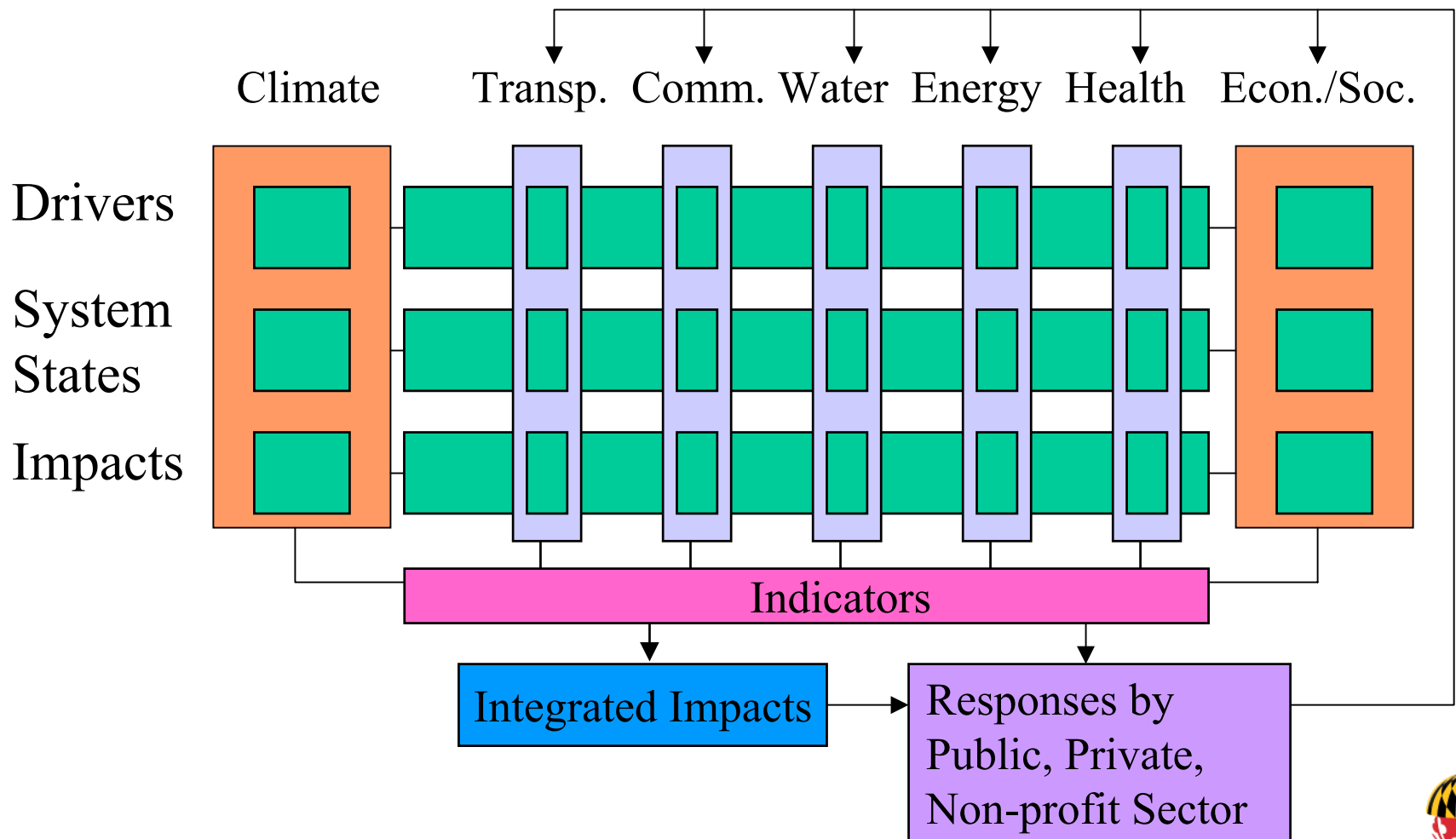
CLIMB

– *Project Structure* –

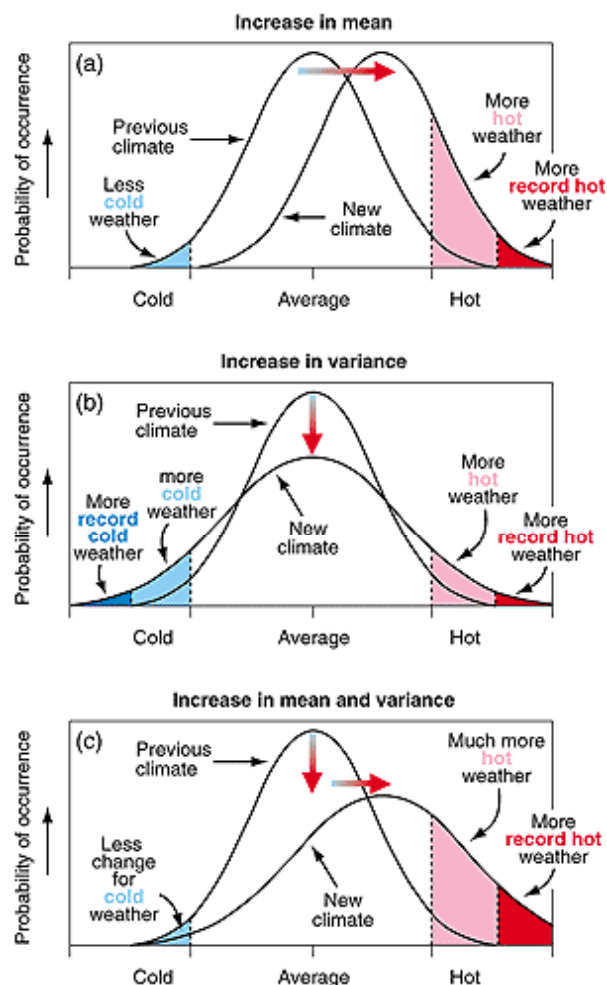


CLIMB

– *Information Management, Modeling,
and Scenario Development* –



Changes in Temperature Mean and Variance

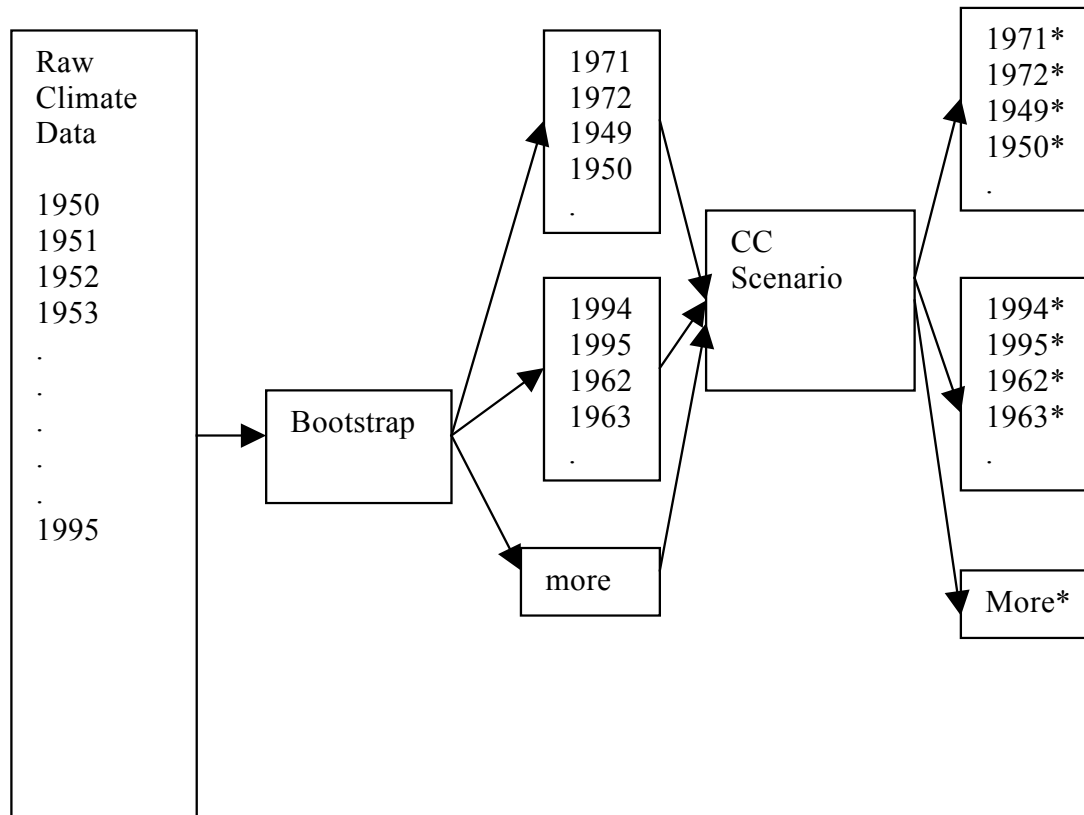


(Source: IPCC 2001)



Bootstrapping

Bootstrapping Process to Generate Climate Time Series



Climate Data Software



Climate Data Software

– Daily to Hourly Drill Down –

View, Mine Hourly Data

Search/Select

From Date: 1/1/1961 To Date: 8/31/1974

☒ All Days with MaxTemp = 94

☐ All Days with MaxTemp >

☐ All Days with MaxTemp <

All Fields ☒ Temp ☐
Dew Point ☐
Heat Index ☐
Wind Vel ☐

Redisplay Daily

Heat Waves

StartDate	Days
7/27/1964	2
6/7/1965	2
7/2/1966	2
7/11/1966	3
6/16/1967	2
6/30/1968	3
7/15/1968	2
7/22/1968	2

Export Heat Waves

Cold Waves

StartDate	Days
1/4/1912	4
1/10/1912	5
1/16/1912	2
1/25/1912	8
2/3/1912	4
2/9/1912	5
2/29/1912	7
1/13/1913	2

Export Cold Waves

Daily

Date	MaxTemp	MinTemp
9/11/1961	94	7
7/25/1963	94	7
7/29/1963	94	7
6/20/1964	94	6
6/30/1964	94	6
7/27/1964	94	6
6/27/1966	94	6
6/16/1967	94	7
6/28/1969	94	7
7/16/1969	94	7
8/15/1970	94	7
8/16/1970	94	7

20 Days

Display Hourly

Export These Days

Export Extreme Days by Temp

Logan Airport

1961 From Hour: 1 To Hour: 24

Hour	Temp	RelHum%	HeatIndex
7	74	74	74
8	78	67	78
9	83	59	86
10	87	48	89
11	89	44	91
12	91	41	93
13	93	38	95
14	93	38	95
15	94	38	96
16	92	40	94
17	90	44	92
18	87	51	90
19	84	57	87
20	82	65	85

Date 9/11/1961 Hour 4

MaxTemp Wind Spd

MinTemp Wind Dir

Precip Pressure

Comments

Exhibits

Basic Boston Model

3 Regions Winter Even

All Monthly

Days>88 Degr w/Hour

Sheets to Build

Sheets: 0

Clear

Build Excel

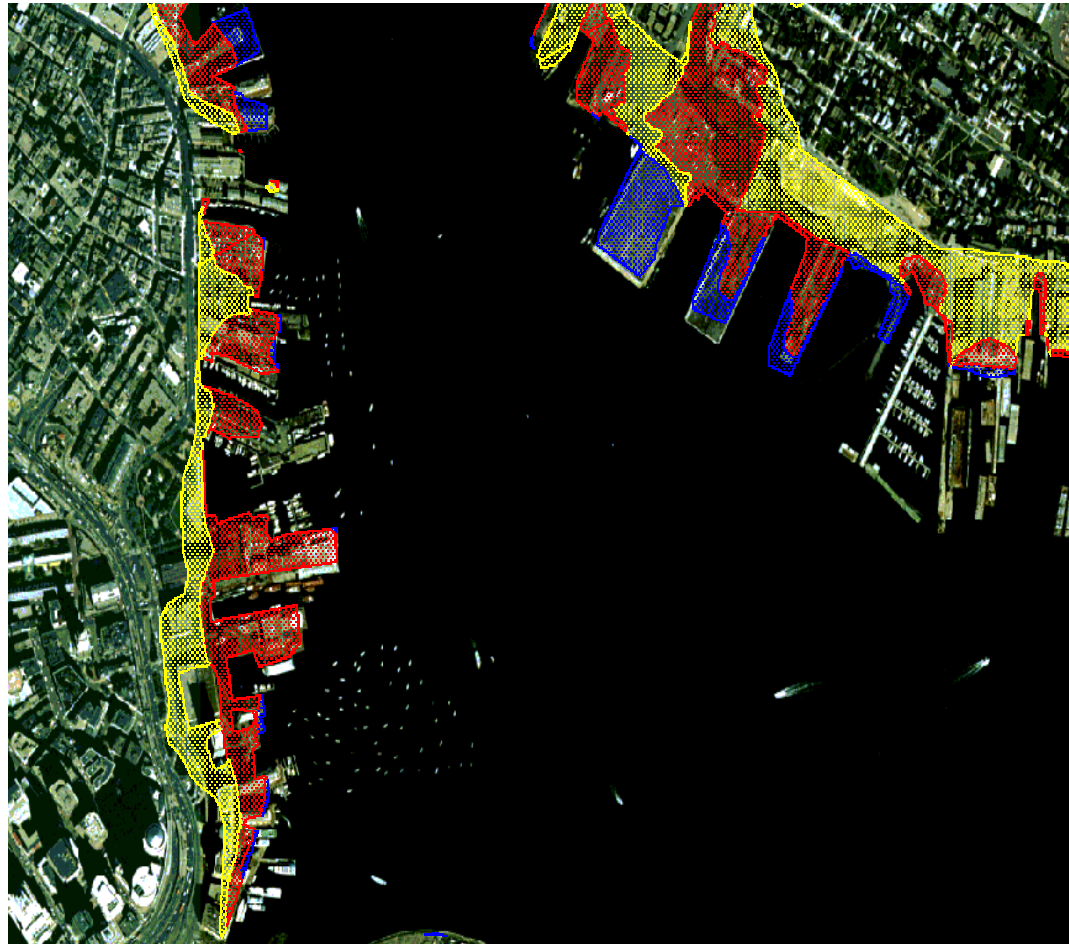
F1 - Help F2 Search Print Graph F3 - Edit Aggregate Hourly Exit



Sea Level Rise Illustration for Nahant



Sea Level Rise Boston Harbor



Storm Surges



Scenarios

Title	Policy	Demographic	Economic	Technology
“Ride It Out”	Present trends in region continue. There are no adaptation actions. Current subsidies for automobiles continue.	Same as current MAPC scenario of continued sprawl, low population growth rate, major growth at fringes and outside of region.	Same employment by sector as current MAPC scenarios.	Low rate of penetration of green and innovative technology by sector.
“Green”	Restrictions on construction locations. Stronger bldg codes. Renewable energy. More mass transit. Natural hazard zoning. No more sea walls except for major commercial areas. Emphasis on more centralized development.	Same population growth as “Ride It Out” but more centralized in line with policy scenario.	Same as above.	Higher rate of green technology penetration than “Ride It Out”.
“Build Way Out”	Same as “Ride It Out” but replace and protect systems as they fail.	Same as “Ride It Out”	Same as “Ride It Out”	Same as “Ride It Out”



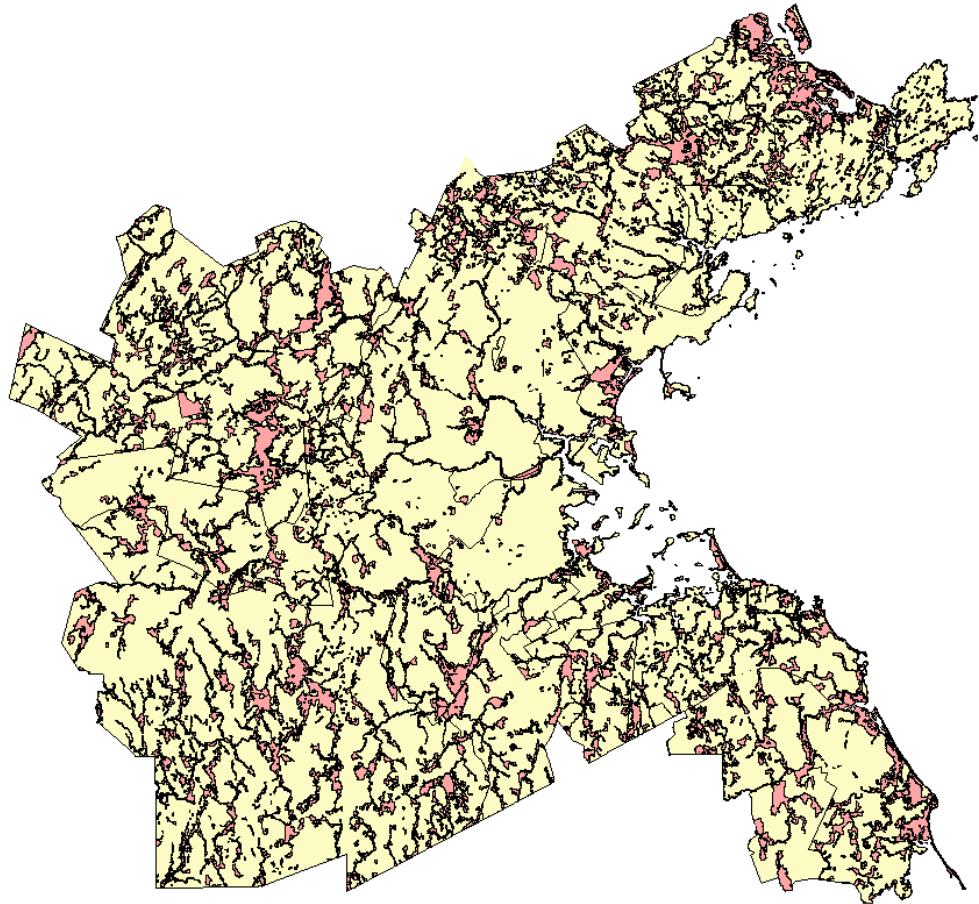
Storm Surge Flooding

Scenario	Cummulative Damage (mil of \$ over 100 years)	Cummulative Land at Risk (Res, Comm, Ind Hectares)
Continue Present Conditions	593.3	4,597.3
RIO - CCC Climate Scenario, MAPC Population Scenario	2,419.2	18,955.8
Green - CCC Climate, no development, no reoccurring damages	86.3	672.9
BYWO	Length of Protection (km)	Wetlands At Risk (Hectares)
Existing Walls	553.1	805.5
New Walls	579.8	2110.1
Projected	in progress	in progress

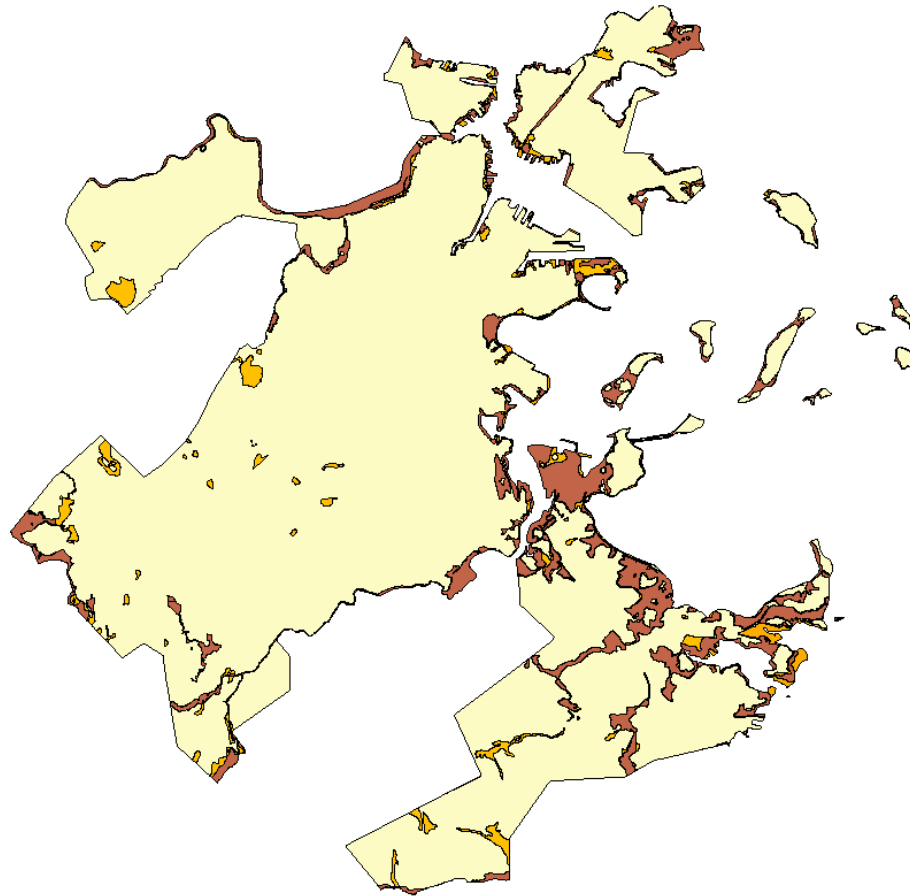


Transportation

FEMA Flood Map for CLIMB Region

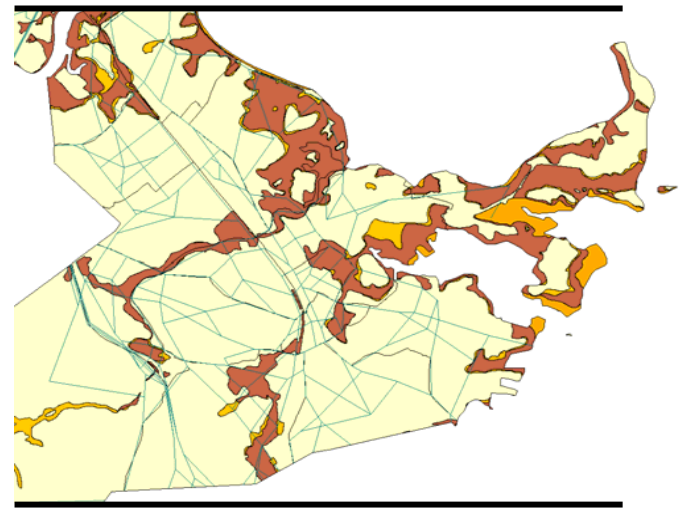
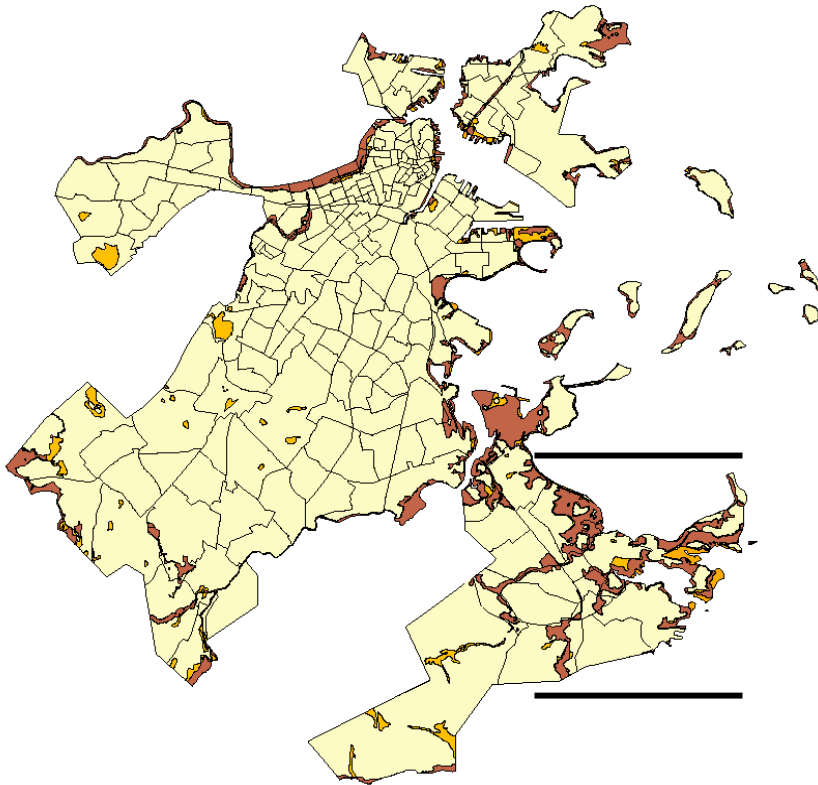


Transportation Flood Plains in Region 1

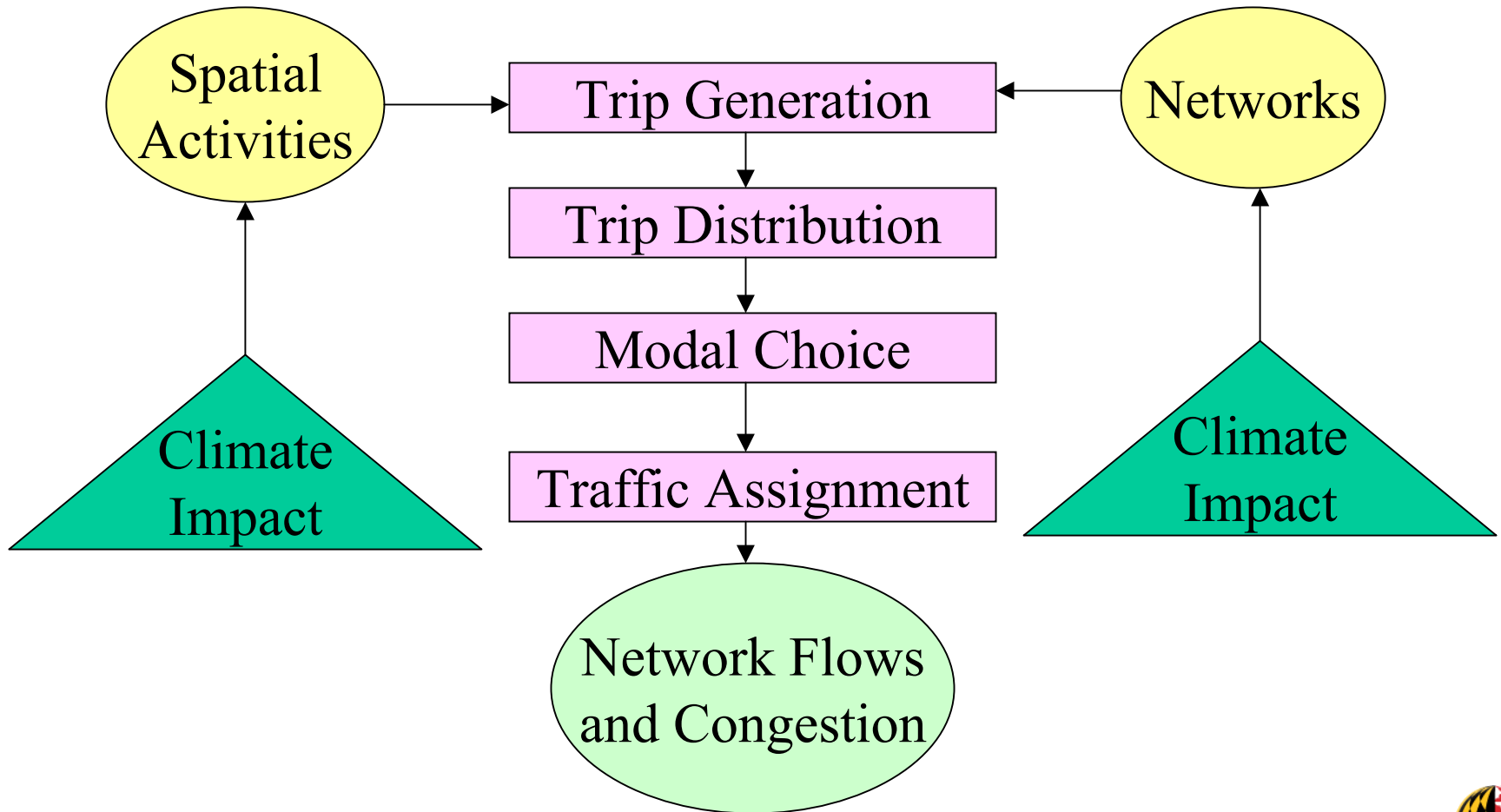


Transportation

Overlay of Traffic Analysis Zones



Transportation

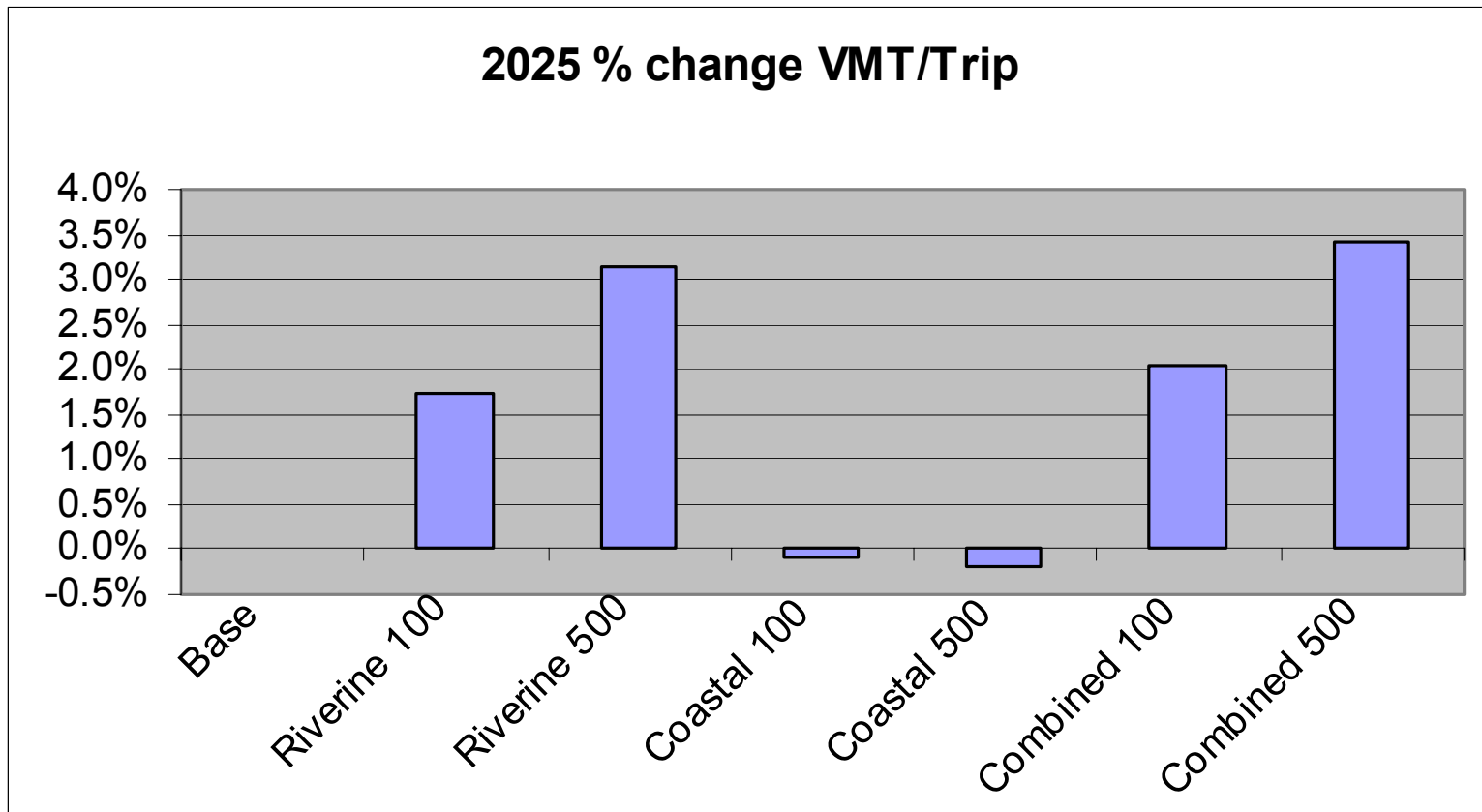


Transportation Scenario Results

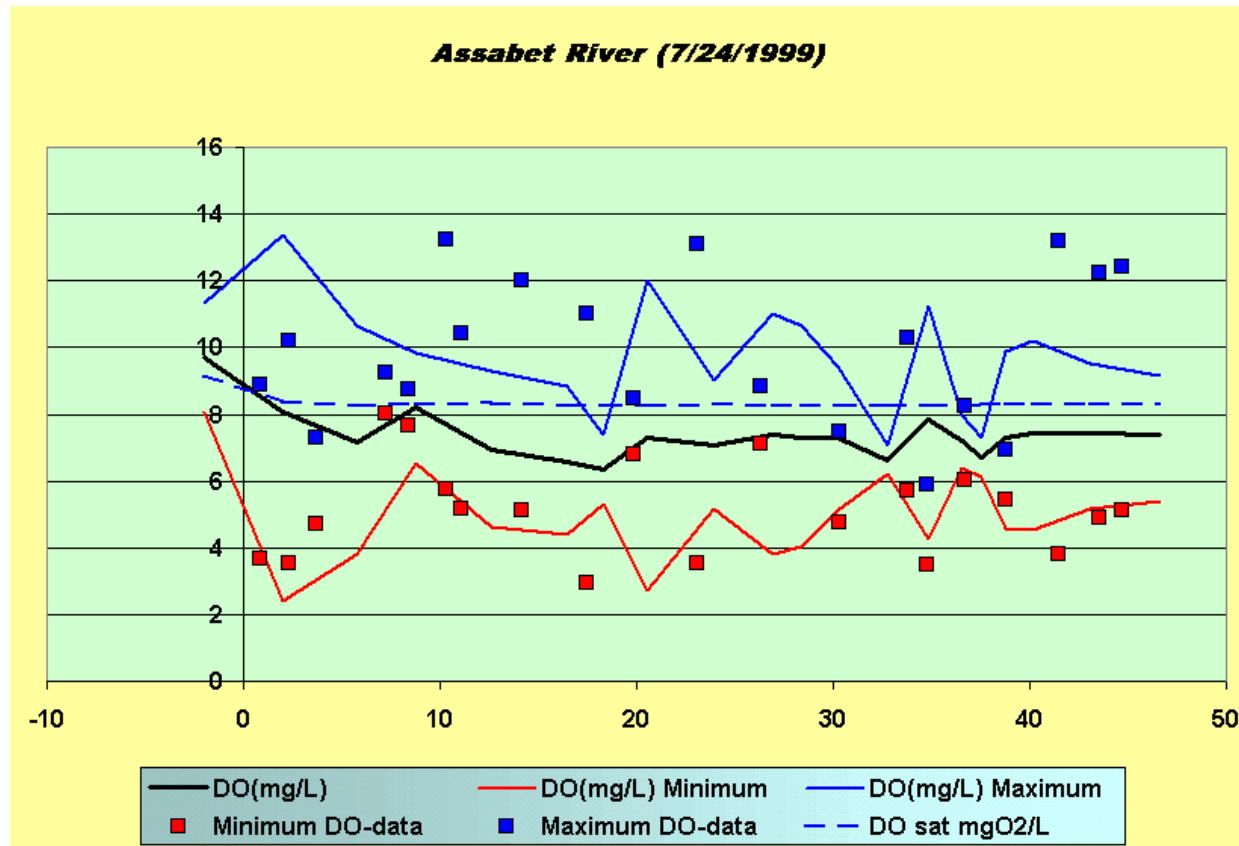
2025 Model Results		Riverine Flooding		Coastal Flooding		Combined	
		100 Year	500 Year	100 Year	500 Year	100 Year	500 Year
		change	change	change	change	change	change
Links Deleted	0	445	673	196	236	641	908
Travel Impacts							
Total Trips	16,454,769	-96,905	-164,576	-165,272	-184,876	-193,440	-224,945
VMT	158,717,552	1,824,400	3,358,688	-1,711,168	-2,079,520	1,321,200	3,177,536
VHT	4,562,397	197,655	346,581	-43,712	-53,685	206,561	380,685
Avg. Speed	34.79	-1.06	-1.77	-0.04	-0.05	-1.23	-2.04



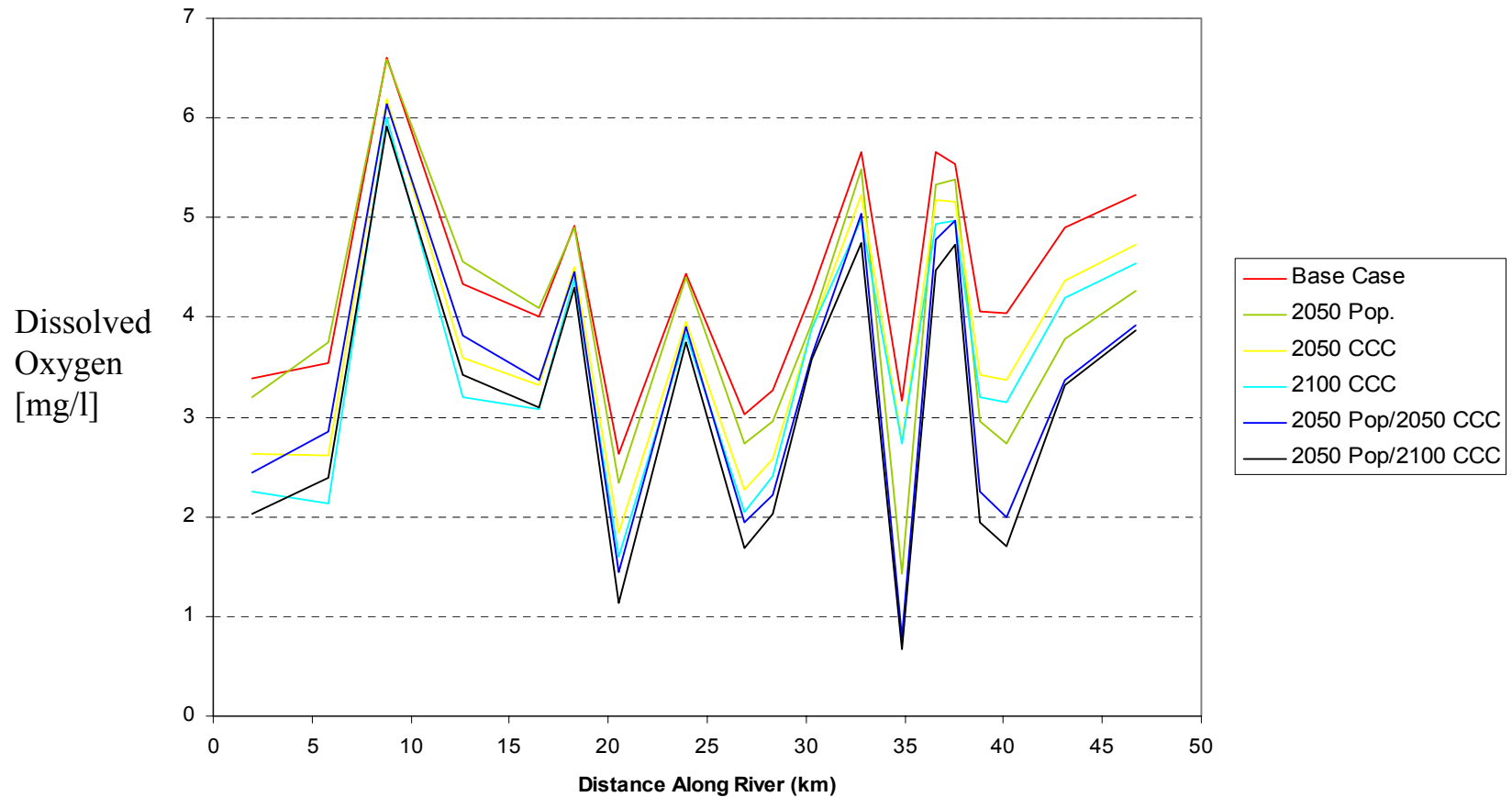
Transportation Scenario Results



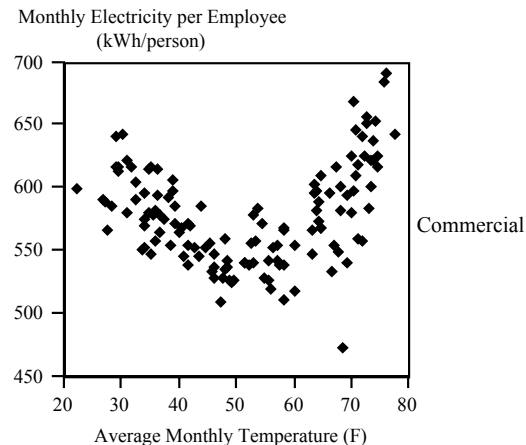
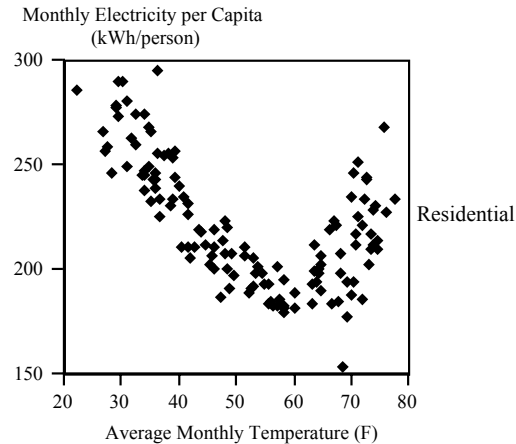
Water Quality Simulations for Assabet River



Model Results for Various Scenarios

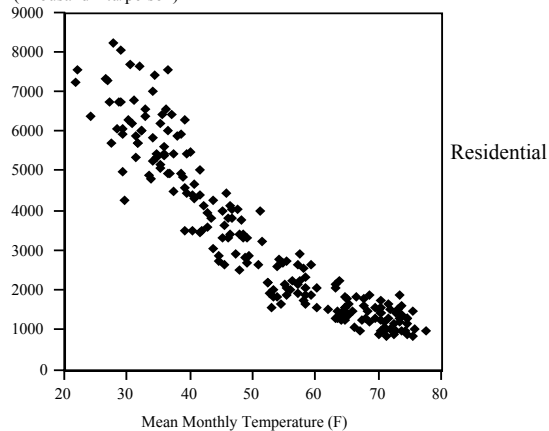


Average Monthly Temperature and Electricity Consumption

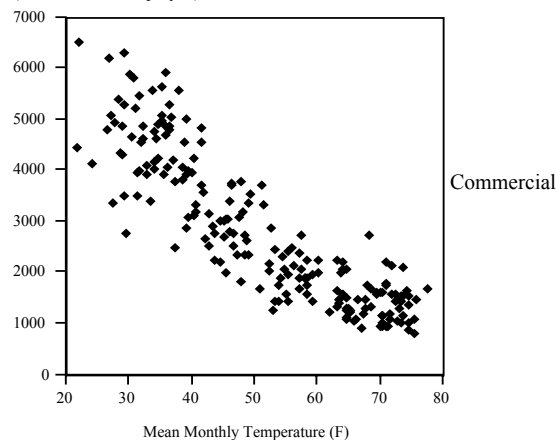


Average Monthly Temperature and Heating Fuels Consumption

Monthly Natural Gas & Heating Oil per Capita
(Thousand Btu/person)

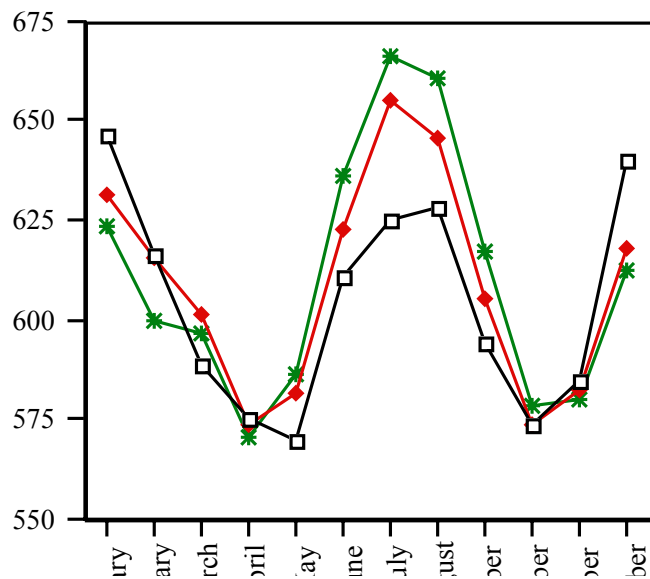


Monthly Natural Gas & Heating Oil per Employee
(Thousand Btu/employee)

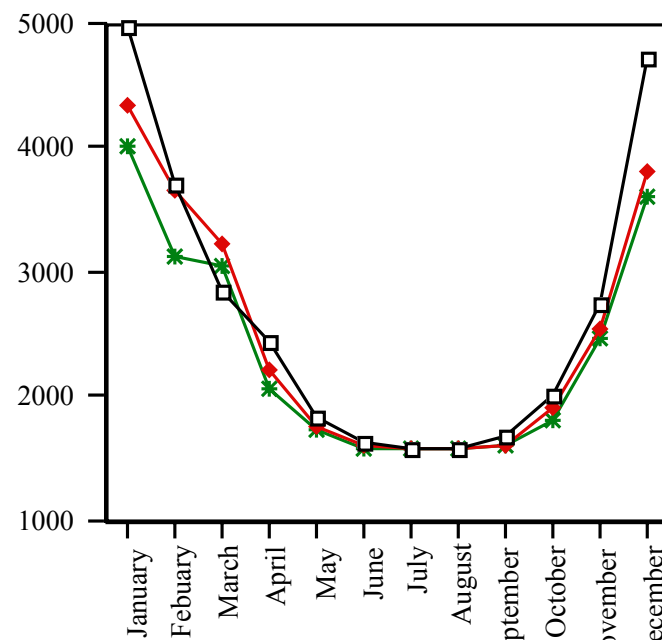


Residential Electricity and Heating Fuel Use

Electricity per Employee
(kWh/employee/month)



Heating Fuels per Employee
(1000 btu/employee/month)

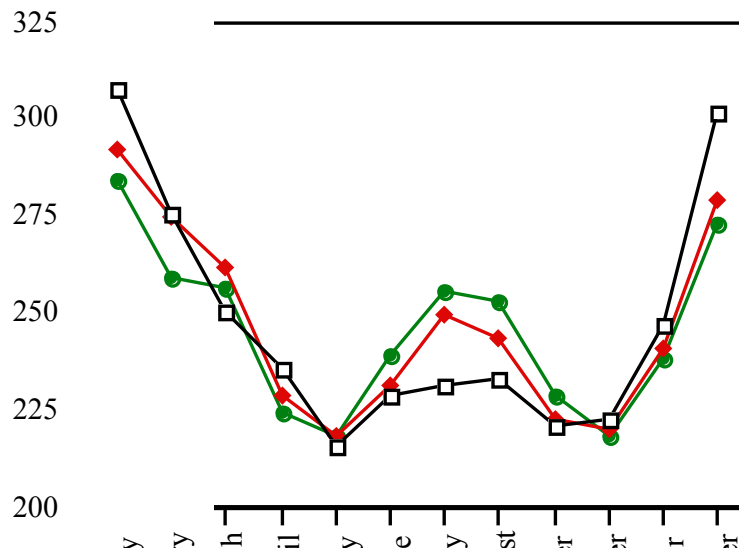


—□— 2000 —♦— 2020 —*— 2050

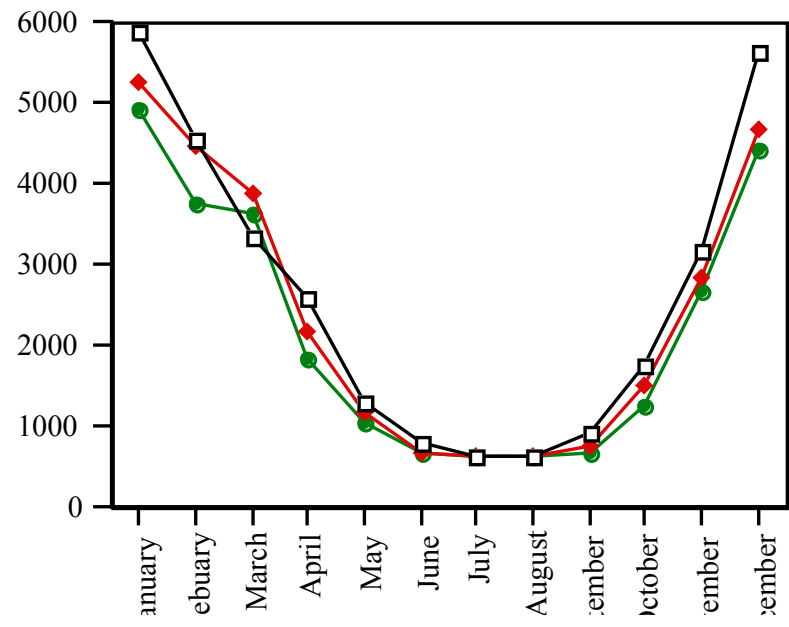


Commercial Electricity and Heating Fuel Use

Electricity per Capita
(kWh/person/month)



Heating Fuels per Capita
(1000 btu/person/month)

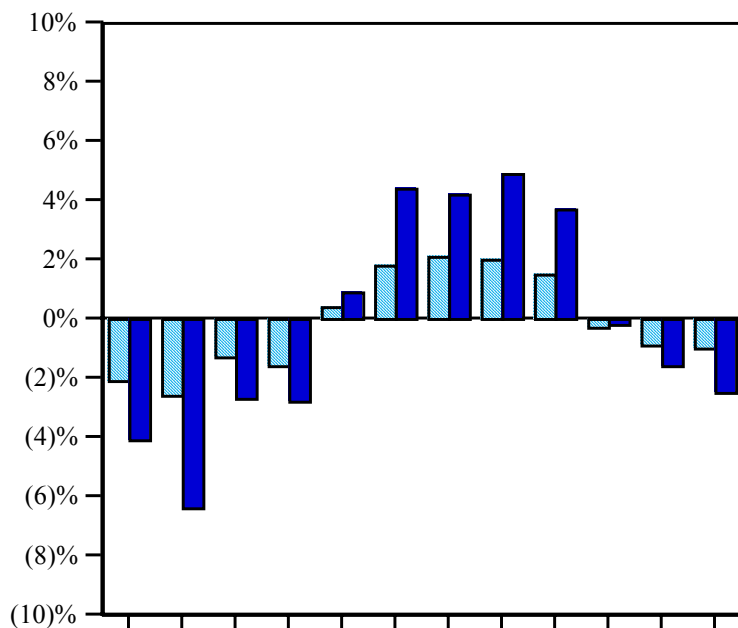


—□— 2000 —◆— 2020 —●— 2050

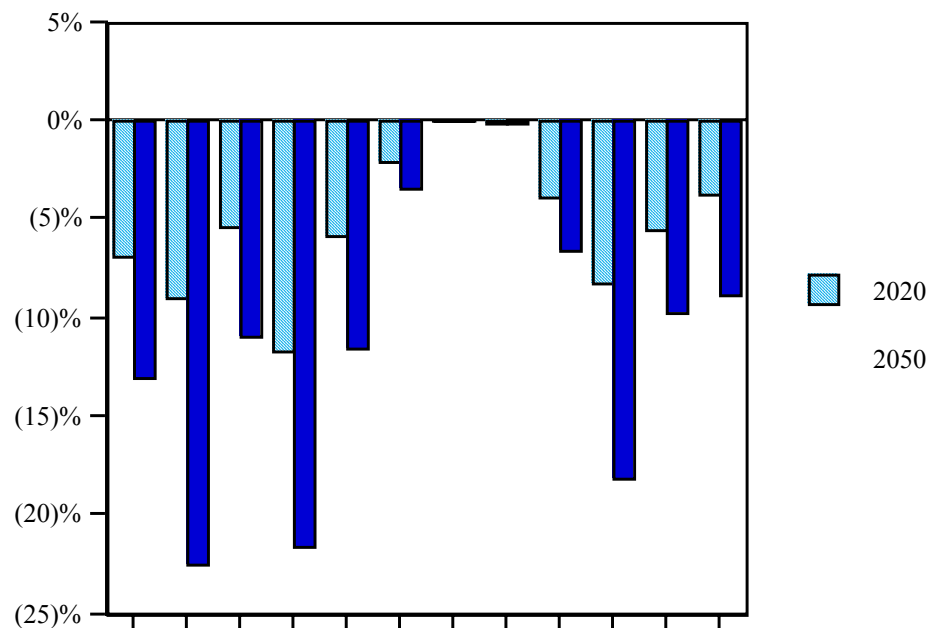


Changes in Electricity and Heating Fuel Uses

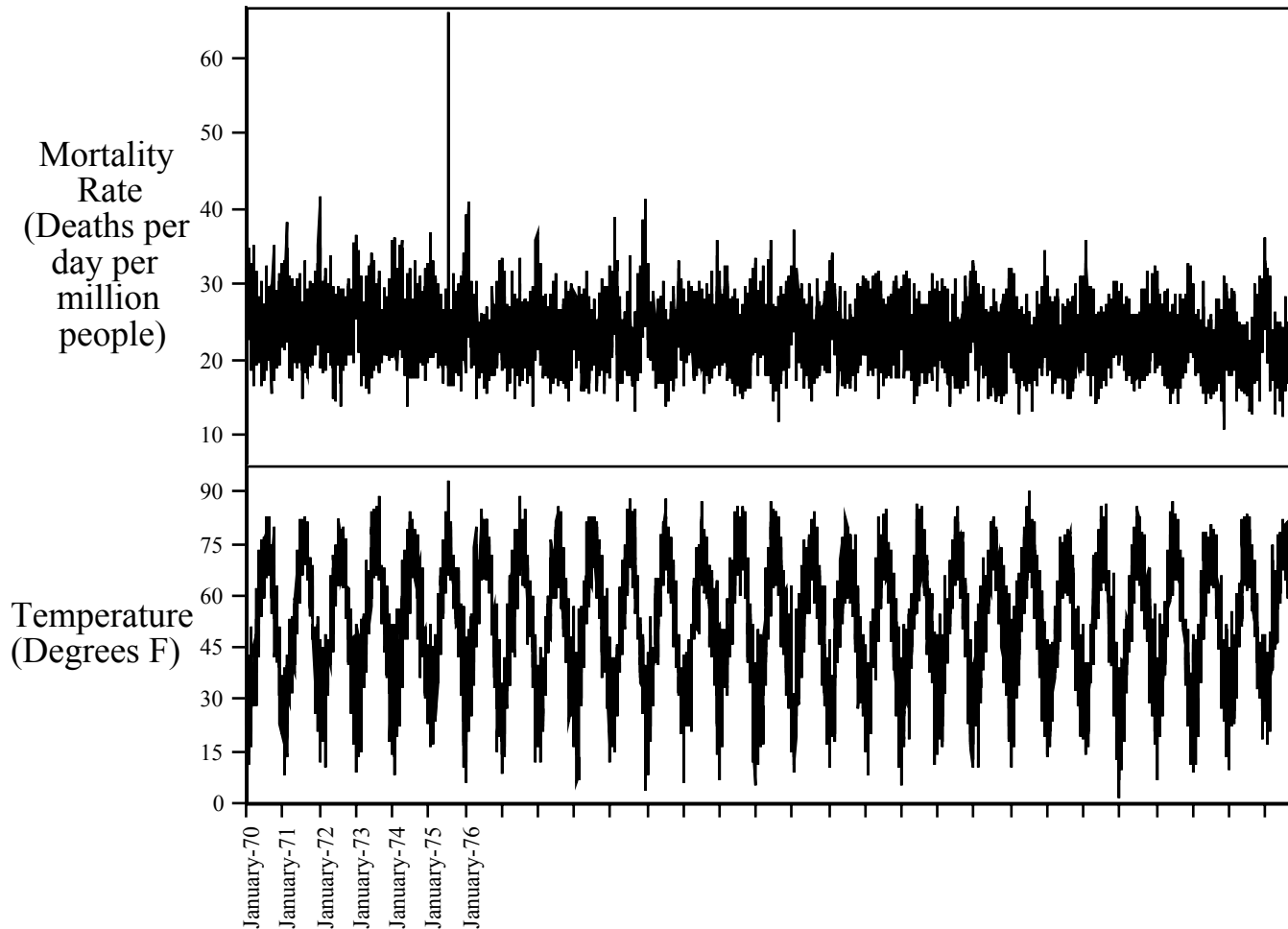
Change in Electricity Use



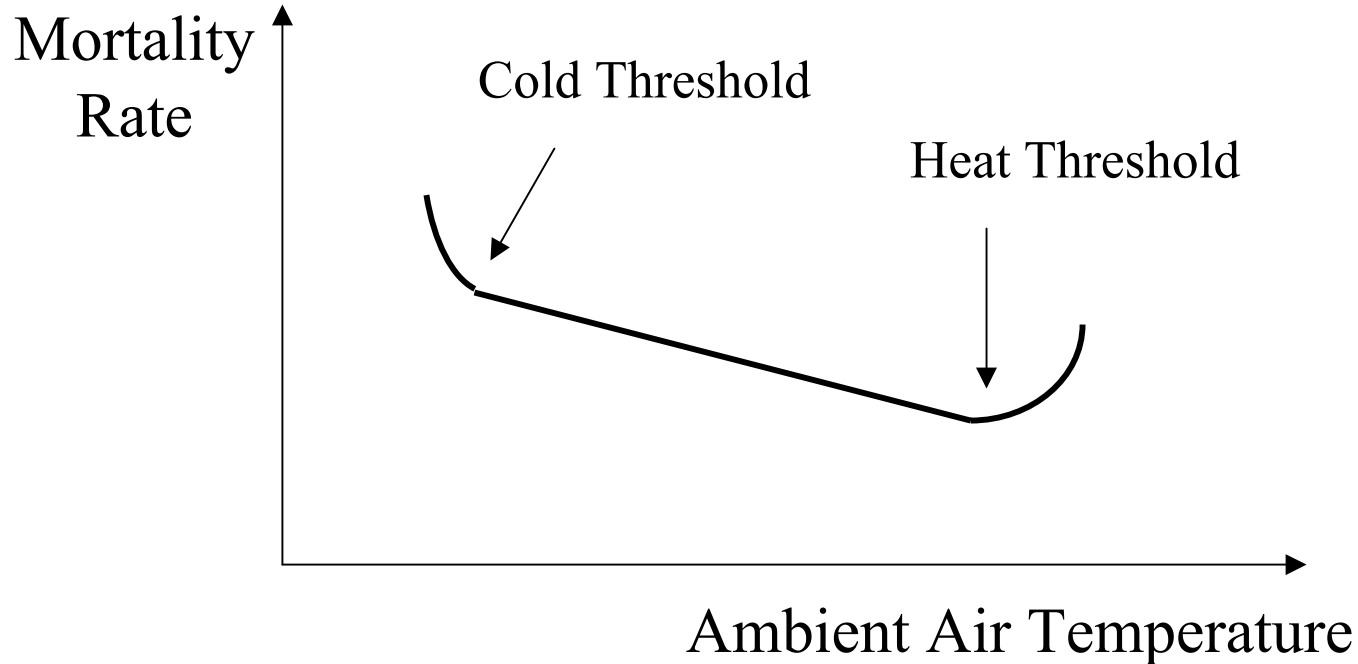
Change in Heating Fuel Use



CLIMB Regional Daily Mortality Rate and Average Temperature

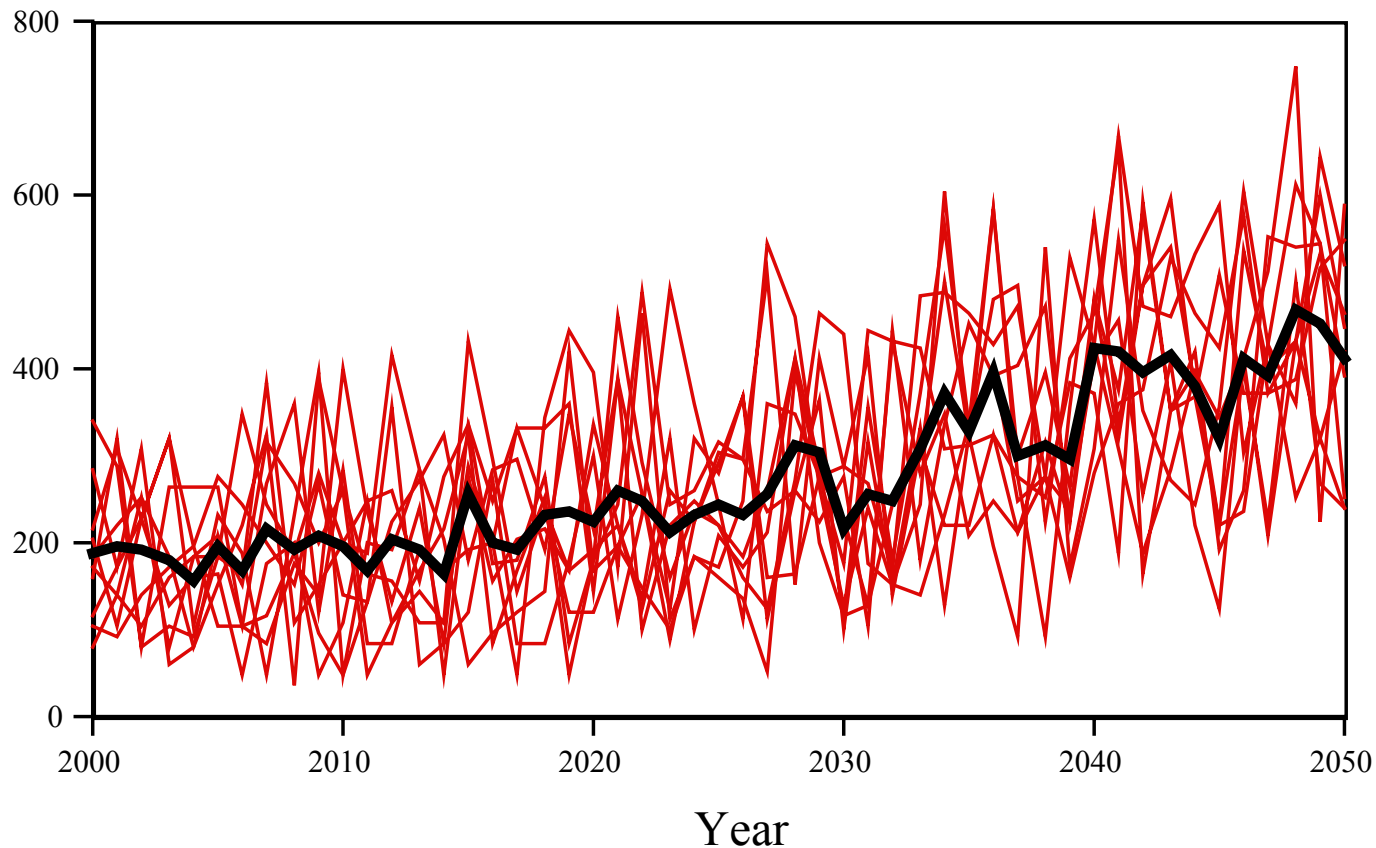


Temperature - Health Relationships



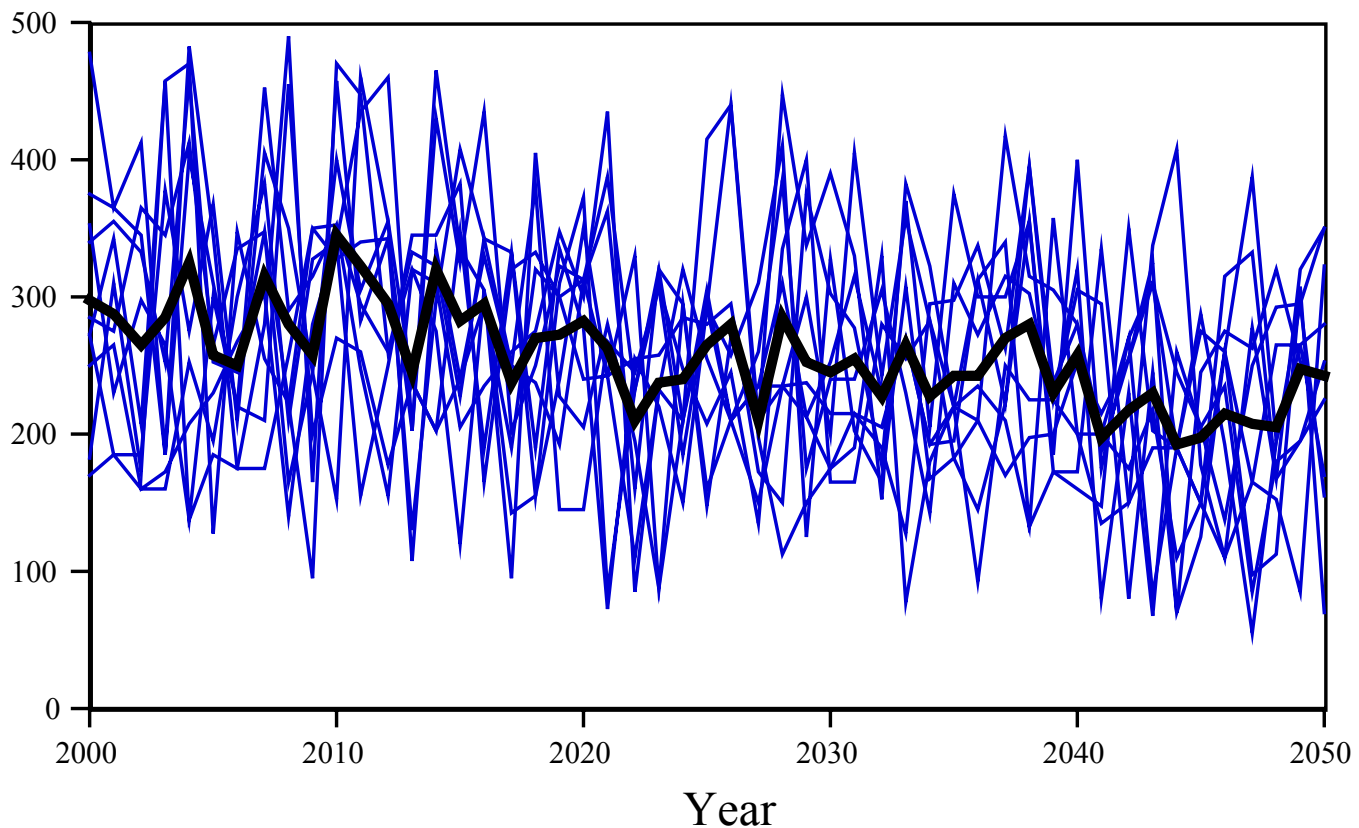
10 Bootstrap Projections of Heat-related Mortality

Heat-Related Deaths per Year

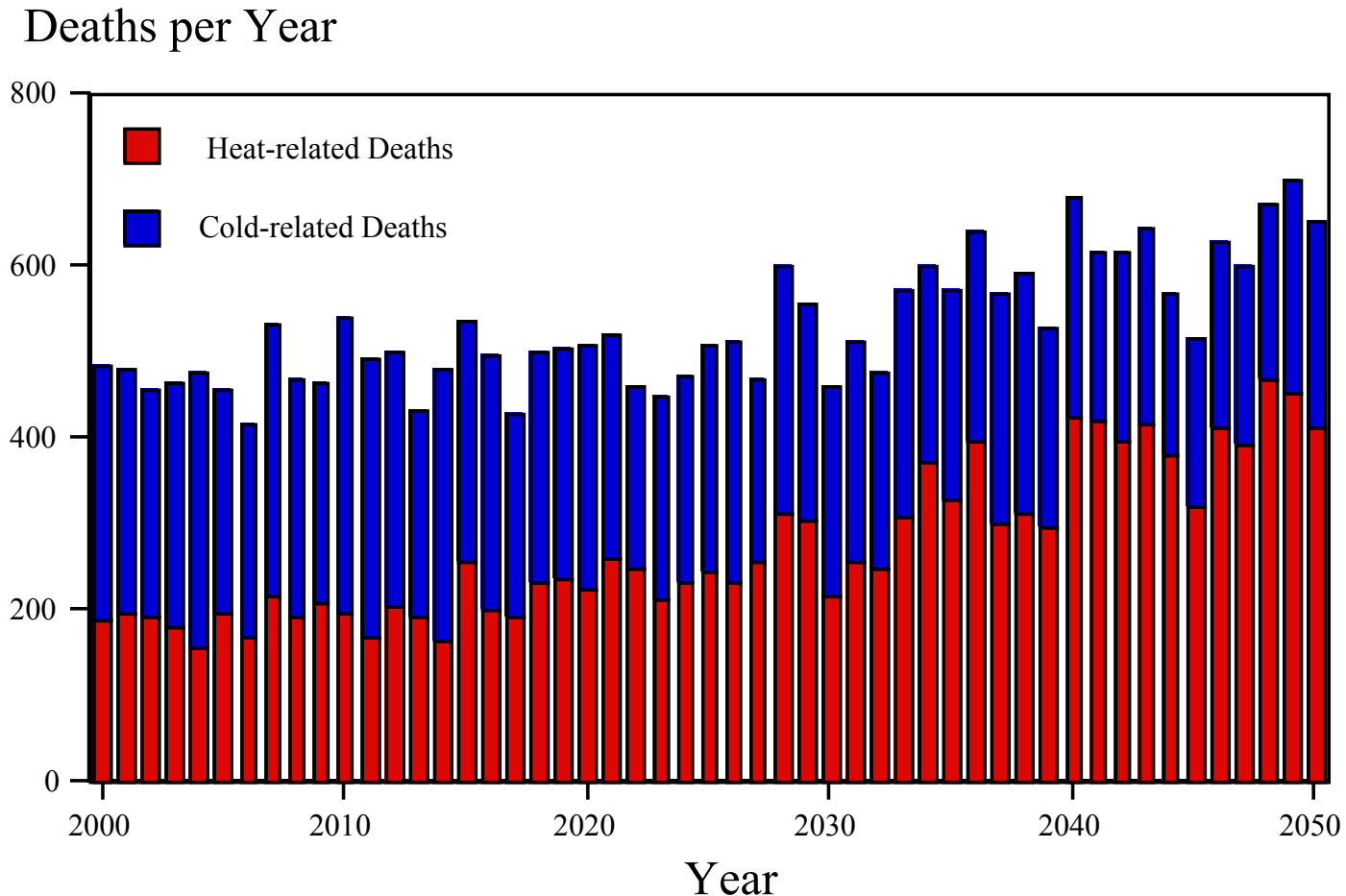


10 Bootstrap Projections of Cold-related Mortality

Cold-Related Mortality per Year



Projections of Temperature-related Mortality



Six Challenges for Research, Education and Decision Making

- ❑ Avoid Environmental Ambulance Chasing
- ❑ Foster Diversity of Problem Solving Approaches
- ❑ Leverage Interdependencies among Infrastructures and Institutions
- ❑ Implement Forward-looking Design Criteria and Standards
- ❑ Get Multiple Bangs for the Buck
- ❑ Promote International Collaboration

